

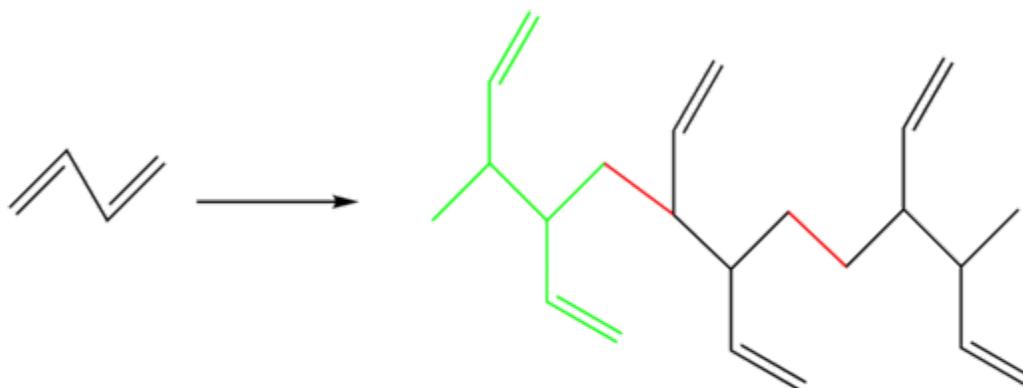
Polymerization of Conjugated Dienes

Conjugated dienes (alkenes with two double bonds and a single bond in between) can be polymerized to form important compounds like rubber. This takes place, in different forms, both in nature and in the laboratory. Interactions between double bonds on multiple chains leads to cross-linkage which creates elasticity within the compound.

Polymerization of 1,3-Butadiene

For rubber compounds to be synthesized, 1,3-butadiene must be polymerized. Below is a simple illustration of how this compound is formed into a chain. The 1,4 polymerization is much more useful to polymerization reactions.

1,2-Polymerization of 1,3- Butadiene



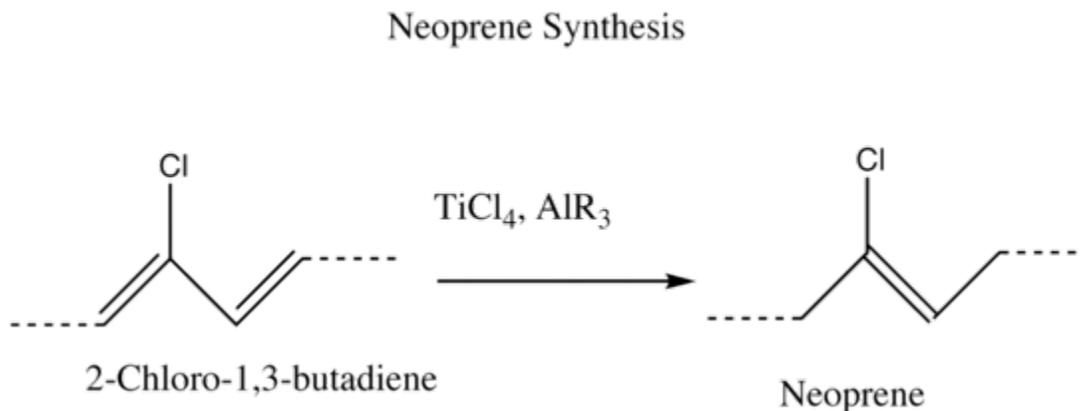
1,4-Polymerization of 1,3- Butadiene



Above, the green structures represent the base units of the polymers that are synthesized and the red represents the bonds between these units which form these polymers. Whether the 1,3 product or the 1,4 product is formed depends on whether the reaction is thermally or kinetically controlled.

Synthetic Rubber

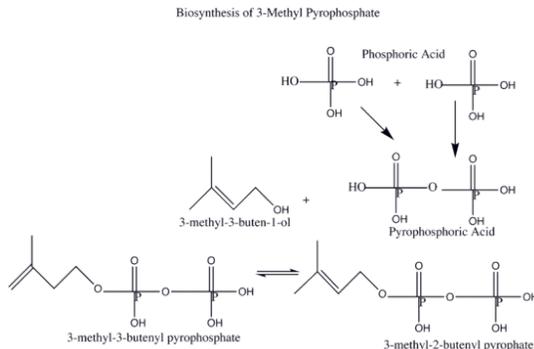
The most important synthetic rubber is Neoprene which is produced by the polymerization of 2-chloro-1,3-butadiene.



In this illustration, the dashed lines represent repetition of the same base units, so both the products and reactants are polymers. The reaction proceeds with a mechanism similar to the [Friedel-Crafts](#) mechanism. Cross-linkage between the chlorine atom of one chain and the double bond of another contributes to the overall elasticity of neoprene. This cross-linkage occurs as the chains lie next to each other at random angles, and the attractions between double bonds prevent them from sliding back and forth.

Natural Rubber

The synthesis of rubber in nature is somewhat similar to the artificial synthesis of rubber except that it takes place within a plant. Instead of the 2-chloro-1,3-butadiene used in the synthesis of neoprene, natural rubber is synthesized from 2-methyl-1,3-butadiene. As an electrophile, the plant synthesizes the pyrophosphate 3-methyl-3-butenyl pyrophosphate from phosphoric acid and 3-methyl-3-buten-1-ol. This pyrophosphate then catalyzes the reaction that leads to natural rubber.



The 3-methyl-3-butenyl pyrophosphate (OPP) is then used in the polymerization of natural rubber as it pulls electrons off 2-methyl-1,3-butadiene (see questions section for this process.)

Source: http://chemwiki.ucdavis.edu/Organic_Chemistry/Conjugation/Polymerization_of_Conjugated_Dienes